QUARTERLY TECHNICAL PROGRESS REPORT

FOR THE PERIOD ENDING

SEPTEMBER 30, 2000

For DOE Grant Entitled

"ENHANCED OIL RECOVERY WITH DOWNHOLE VIBRATION STIMULATION IN OSAGE COUNTY OKLAHOMA"

Contract Number:	**DE-FG26-00BC15191**
Contractor:	**Oil & Gas Consultants International, Inc. 4111 So. Darlington Suite 700 Tulsa, Oklahoma**
Contract Date:	**July 13, 2000**
Anticipated Completion:	**November 12, 2001**
Government Award:	**$430,000 (Current Year)**
Principal Investigators:	**J. Ford Brett Robert V. Westermark**
Project Manager:	**Virginia Weyland National Petroleum Technology Office**
Reporting Period:	**July 1, 2000 – September 30, 2000**

Disclaimer

Abstract

This Technical Quarterly Report is for the reporting period July 1, 2000 to September 30, 2000. The report provides details of the work done on the project entitled “Enhanced Oil Recovery with Downhole Vibration Stimulation in Osage County Oklahoma”.

The project is divided into nine separate tasks. Since this is the first Quarterly report, much of the work done is of a preliminary nature. Several of the tasks are being worked on simultaneously, while other tasks are dependent on earlier tasks being completed.

The selection of the pilot test area has been completed. The drilling of the test well is waiting on rig availability. Phillips has begun sonic core testing of offset cores, waiting on the core from the well to be drilled. Design work is progressing for the tool, which will be built to fit the test well. Installation of monitoring equipment and the downhole vibration tool will occur after the well is drilled. Technical transfer efforts have begun with the submission of an abstract for a technical paper for the Oklahoma City Society of Petroleum Engineers meeting in March 2001.

TABLE OF CONTENTS

List of Graphical Material Page

Introduction

The objective of this project is to demonstrate the impact of downhole vibration stimulation on production rates in a mature waterflood field. Oil and Gas Consultants International, Inc. (OGCI) will manage the project in close cooperation with the Osage Tribe as the tests will be conducted in Osage County, Oklahoma, the mineral estate of the Osage Tribe. The field is owned and operated by Grand Resources, Inc. Phillips Petroleum Company will contribute their proprietary vibration core analysis of cores recovered from the pilot test area.

To achieve the project objectives, the work has been divided into nine tasks, some are concurrent, while other tasks rely on completion of previous steps. The initial task is a review of the available fields operated by Grand Resources, Inc. in Osage County Oklahoma to determine the appropriate pilot test area. Once the field is selected, Grand Resources, Inc., will maintain current field operations, collecting base-line production and injection data. The team will then determine where within the field to optimally locate the vibration test well. With the location determined, the test well will be drilled, cored, logged and 7" production casing run and cemented.

In a parallel effort, OGCI will be designing, building, and testing a new version of the downhole vibration tool based on their patented and field proven whirling orbital vibrator. With the field test tool built to run in 7" casing, duration testing of the downhole tool and surface power source will be conducted in nearby field operated by Grand Resources, Inc.

After the core is recovered, Phillips Petroleum Company will be conducting laboratory tests utilizing their proprietary sonic core apparatus to determine fluid flow response to a range of vibration frequencies. These results, in turn, will allow final adjustments to the frequency generation mechanisms of the downhole vibration tool.

An offset well, adjacent to the vibration test well, will be equipped with downhole geophones to determine strength of signal and if the producing formation has a characteristic resonant frequency response. Surface geophones will also be set out and arranged to pick up the signal generated by the downhole vibration tool.

The downhole vibrator will be installed in the test well. Monitoring the production and injection for the pilot test area will continue. As the frequency of the downhole tool is changed, the recording of seismic signals, both on the surface and downhole, will also be conducted. The results of the data collection will be a matrix of varying vibration stimulation conditions corresponding to changes in production fluid rates and seismic responses.

The report on the results of the downhole vibration stimulation will be prepared and delivered using several venues. Technical papers will be submitted to the Society of Petroleum Engineers and workshops are planned to be held for operators in Osage County and surrounding areas. A dedicated technical session on vibration stimulation may be offered at the 2002 SPE/DOE/IOR Conference, bringing together the world's experts in this emerging technology. The final task will be to close out the project.

Executive Summary

Contract Status:

Under DOE advisement, the project activities began June 14, 2000, although the contract was signed on July 13, 2000.

Financial status:

Two advance requests for funding have been submitted and the requested total of $181,160 has been received. As of September 30, 2000, $49,984 has been dispersed with an additional $45,000 committed for work in progress. Spending is behind schedule approximately $90,000, since the drilling operation has been delayed.

Schedule Status:

The project schedule had slipped two week as of September 30, 2000, due to delays in drilling the test well. The drilling delays have not yet had a major impact on the overall project schedule because other activities, which are on the project's critical path, are being conducted simultaneously.

Technical Progress:

A meeting was held to begin the process of selecting the field in which to conduct the test. The Blazer Field was selected as the pilot test area. The location was determined and the well location built for the drilling of the Blazer Well # 18 A, in the autumn. However, high natural gas and oil prices caused a very tight rig market to develop in northeastern Oklahoma and the test well has not yet been drilled. Discussions with several drilling rig contractors indicate the well should be drilled before the end of the year.

To avoid delaying the project, the team was able to obtain for Phillips, samples from an existing core from a well approximately five miles from the proposed pilot test area. Based on logs from the cored well and the logs from the Blazer field, these cores should be representative of the Blazer test well cores. The test well will still be cored and the cores tested in the Phillips proprietary sonic test cell.

OGCI has designed, built and tested a prototype tool, which has demonstrated an improved degree of reliability over earlier versions of the patented downhole vibration tool. The design for the field test tool is continuing on schedule.

Experimental

Sonic Core Testing

Phillips Petroleum Company has developed a proprietary technique for conducting sonic core tests. It is anticipated that Phillips will release information regarding this process later during the project.

Vibration Stimulation Field Testing

At this time there is nothing to report concerning the procedures regarding the procedures for conducting the vibration stimulation field tests.

Results and Discussion

This section of the quarterly report reviews in detail, the progress made during the quarter on each of the project's major tasks and sub-tasks.

Task 1: Define Most Appropriate Test Area

- *Meet as team to review field production history and scope possible locations.*

The project team met to review Grand Resources, Inc.'s Osage County waterflood operations. Four field histories, well logs, production and injection records were reviewed. Based on the current field operations and well conditions the Blazer Field was chosen for the pilot test area, Sections 6 and 7 T26N and R11E, Osage County, Oklahoma. Please refer to Figure 1 for Blazer Field location.

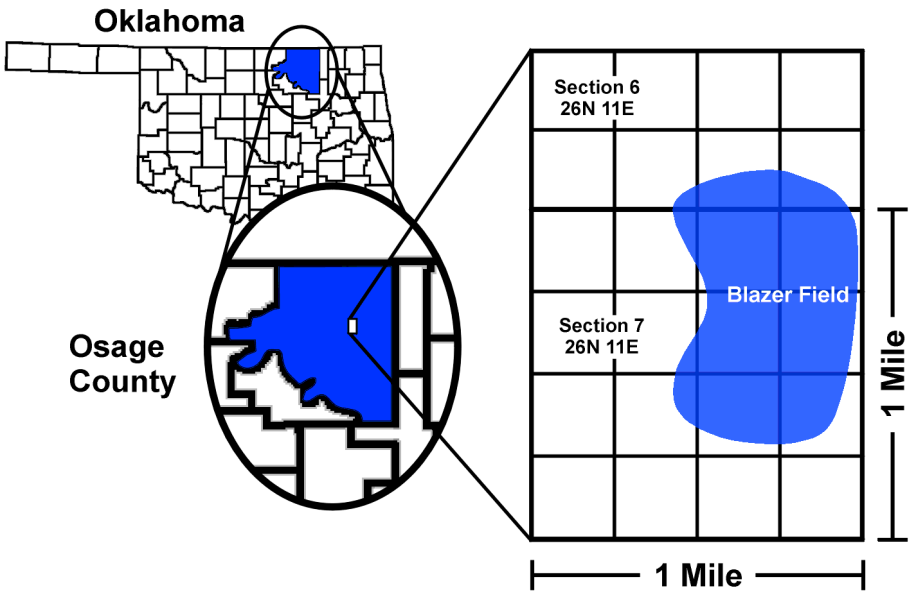

Figure 1 Location of Blazer Field Osage County, Oklahoma

- *REVIEW WELL LOGS, PRODUCTION RECORDS ETC. AND DETERMINE A PROPOSED TEST WELL LOCATION*

The Blazer Field, Bartlesville Sand reservoir was discovered in June 1984. The field was uneconomically developed from 1984 to 1987with the drilling of the first five wells. Well 6-A came in strong and the field development occurred rapidly. Peak primary production was 4300 BOPD in February 1988. Estimated primary production is 70,000 bbls oil, which is about 50% of the total field production to date.

A waterflood was initiated in June 1989 with the conversion of the 8 A well, quickly followed by converting Wells 2 C and 5A to injection. Well W 2 was drilled specifically as an injector. Peak secondary production occurred November 1989 at 2800 BOPD. Average injection volumes were 300 BWPD produced water and 300 BWPD make up water.

Currently the field has seven producing wells producing approximately 10 BOPD and 200 BWPD, three wells injecting all the produced water plus 75 BWPD of make-up water.

- *MEET TO DEFINE DRILLING LOCATION*

With the Blazer production and injection history, well histories and logs cross-sections organized, a meeting was held to select the location of the vibration stimulation well. Three criteria were used to assist in determine the location for the test well:

1. Select an area that has good net pay.

   The areas in the North and South end of the field have the best-developed porosity and net pay thickness.

2. Select an area that has good residual oil saturation.

   The area in the South end of the field appears to have the highest residual oil content. This has been confirmed with a geo-microbial survey, which indicates higher levels of hydrocarbon remaining in south end of the field.

3. Locate the vibration well as close to a producer to maximize strength of vibration

   This issue was addressed by proposing to dual complete the vibration well. The well will be drilled approximately 200' from two producing wells and approximately 300 ' from the nearest injection well.

- *REPORT TO OSAGE TRIBAL REPRESENTATIVES OF PROJECT PLANS*

On August 25, 2000, a short presentation was made at the request of the Osage Tribal Council Mineral and Mining Committee during a regularly scheduled meeting held in the

Tribal Council Chambers in Pawhuska. Osage Principal Chief Charles O. Tillman conducted the meeting.

The scope of the project was discussed. The working relationships were explained detailing how the Department of Energy, National Petroleum Technology Office in Tulsa was interfacing with OGCI's project management team. Further explained was the working relationship between OGCI, Grand Resources, Inc. and Phillips Petroleum in the field and laboratory respectively. The proposed test well location was described with the anticipated spud date.

Chief Tillman was very appreciative of the level of DOE funding, and recognized that this was a new technology that could be very important to the Osage Tribe. Chief Tillman requested that we provide several days notice prior to spudding the well, to allow for him to organize a photographic opportunity for members of the Tribal Council at the rig. He bid us good luck and to keep the Tribe informed of the project activities.

Since that meeting several discussions concerning vibration stimulation have transpired with the newly appointed Osage Tribe petroleum engineer Joe Hughlett.

TASK 1 MILESTONE: DEFINE TEST AREA

HAS BEEN ACCOMPLISHED

TASK 2 DRILL AND CORE TEST WELL

- *PREPARE THE WELL PLAN AND PERMIT THE WELL*

Grand Resources, Inc. in conjunction with OGCI, prepared the well plan. The well will be air drilled, cored with air, or an air foam mixture, 7" casing run and cemented. The drilling permit for the proposed well, Blazer 18A was submitted August 31, 2000.

- *BID THE DRILLING RIG AND SERVICES*

Drilling contractors were contacted and bids procured by Grand Resources, Inc. The recent up-turn in both oil and natural gas prices has produced a very tight rig market in northeastern Oklahoma. Two contractors have been short listed, based on anticipated availability of their rigs.

Bids for both surface and production casing have been received. Although, due to the delays in obtaining a drilling rig, the casing has not yet been purchased.

Bids for coring services have been received, but again due to the lack of a contracted drilling rig, the coring services have not been selected. The rig layout may dictate which coring equipment can be used and, hence, which coring service will be selected.

- *AWARD THE DRILLING AND SERVICE CONTRACTS*

The drilling contract and the related service contracts have not yet been let since the rig availability is still being negotiated.

- *PREPARE LOCATION*

The location was surveyed September 6, 2000. Damages were settled with the landowner. The Blazer 18 A well location was built under the supervision of Grand Resources, Inc.

- *DRILL, CORE, AND CASE WELL*

This sub task has not yet been performed

- *REPORT TO OSAGE TRIBAL REPRESENTATIVES OF PROJECT PROGRESS*

This sub task has not yet been performed.

TASK 3: DEFINE, CONDUCT & EVALUATE LAB TESTS

- *DEFINE SUITE OF LAB TESTS*

The actual procedures Phillip's uses for the sonic core tests are still being considered confidential. It is anticipated that Phillips will release some information concerning the sonic core testing during this project.

- *REVIEW BARTLESVILLE SANDSTONE FIELD CHARACTERISTICS*

There have been many articles, papers and bulletins published on the Bartlesville Sandstone, a major producing formation in Osage County and all of northeastern Oklahoma. The most recent treatise was a product of a Ph.D. dissertation by Liangmiao Le[1], under the supervision of Professor Dennis R. Kerr entitled "Reservoir Characterization and Sequence Stratigraphy of the Pennsylvanian Bartlesville Sandstone, Oklahoma" (256 pages). This doctoral work was in part sponsored by U.S. Department of Energy, through the Glenn Pool Project "Integrated Approach Towards The Application Of Horizontal Wells to Improve Waterflooding Performance, one of the DOE Class I programs, under the supervision of Dr. Mohan Kelkar.

- *REVIEW OF LITERATURE*

The cornerstone of technical papers on vibration stimulation in the published in the United States is the Beresnev and Johnson[2] paper published in 1984. It reviewed efforts from around the world where various types of vibrations were being applied to increase oil production. The value of the Beresnev and Johnson paper is the consideration of the full spectrum of vibration frequencies from earthquakes to ultrasonic of over 50,000 hertz. Of the many papers discussed, a large number were originally written in Russia. There are numerous English translations of Russian papers dealing with vibration stimulation both from laboratory and field data. The paper entitled "Residual Oil Reservoir Recovery With Seismic Vibrations," by Nikolaevskiy, V.N. et al[3], seems to tie in well with the observations of Phillips sonic core tests, regarding the concept of a dominant or natural frequency of the reservoir.

In recent years, the Chinese [4,5,6,7,8] have been studying the effects of oil recovery with vibration stimulation. Philips Petroleum has provided English translations of five such papers published in connection with studies on the Daqing Oil Field.

- *ANALYZE THE OFFSET CORE*

The offset cores have been x-rayed of occlusions prior to removing 2" diameter plugs for sonic testing. Ten 2" plugs have been drilled from the full cores are being cleaned in preparation for use in the sonic test apparatus.

WORK ON THESE SUBTASKS HAS NOT COMMENCED.

- *CONDUCT LAB TESTS*
- *EVALUATE LAB TEST RESULTS FOR FREQUENCY AND AMPLITUDE*
- *MEET TO REVIEW LAB TEST RESULTS & BRACKET FIELD TEST FREQUENCIES/AMPLITUDES*
- *REPORT TO OSAGE TRIBAL REPRESENTATIVES ON PROJECT PROGRESS*

TASK 4: DESIGN AND CONSTRUCT DOWN HOLE VIBRATION TOOL AND SURFACE POWER SOURCE

- *FRONT END SOURCE ENGINEERING - SELECT MOST APPROPRIATE POWER SOURCE*

Potential power sources to turn the downhole vibrator were reviewed and evaluated. These included: downhole hydraulic motors, downhole electric motors, downhole moyno type drilling motors, surface rod-rotating systems.

The rod rotating system was selected based on cost, minimal anticipated running and pulling complications, surface support equipment required, and modifications required adapting off the shelf equipment to the downhole vibrator tool.

Rod rotating systems have been is service for nearly 30 years and have been thoroughly proven as a reliable mechanism for powering progressive cavity pumps. The system under consideration has a variable speed drive, high torque levels at all RPMs and a fully instrumented package, which can be programmed to automatically change speed in controlled stages.

- *ENGINEER SOURCES TO SPECIFICATIONS*

Three steps to this subtask have been used to develop a robust and reliable downhole tool.

1. Conceptual Prototype.

   The previous versions of the patented OGCI downhole vibration tool were run at shallow depths (200'+/-). During the field tests of the earlier versions (see Figure 2 below of the downhole vibration tools, tremendous seismic response results were obtained. However, starting reliability was less than 100% and after several evolutionary changes, starting still remained an issue. The seismic source tests were conducted for short term cyclic periods and the tool was operated for short periods of time, generally less than half day runs. When long term operation testing was conducted, the results pointed to alignment problems, which were also related to the starting problems.

To solve these earlier shortcomings, a new design was conceived and tested. The conceptual prototype was built based on using flex shafts, rather than universal joints, which had been used previously. The preliminary results were encouraging. A precision prototype was designed and built based on the flex shaft concept.

Figure 2 Downhole vibration tool in earlier version (1995) as a geophysical seismic source

2. Precision Prototype

The precision prototype was designed to be easily handled by an individual, but still fully test the concept of the flexshafts in terms of starting reliability and long term durability.

This version of the tool has proven to start reliably and has shown no signs of durability limitations. A thorough, third party engineering design review has been commissioned to investigate strengths and areas needing improvement. This design review will be used in determining the specifications for the field test version of the downhole vibrator.

3. Field Test Tool

Preliminary discussions have occurred with vendors to supply 'off the shelf' items for the construction of the field test tool. When the design review report is completed, it will be used to set the specifications for the field test version of the downhole vibrator to run in the 7" casing of the test well.

- *CONSTRUCT TOOL(S) & SOURCES*

The field test tool will be designed to use many 'off the shelf' items from downhole tool manufacturers including the housing and slip mechanisms. The machine shop used to build the precision prototype will be used to construct the custom items and assemble those with the standard items such as springs, bearings and seals.

- *SURFACE TEST TOOLS*

Plans are being finalized to conduct the surface testing of the field test tool in conjunction with the power source life testing at the Bird Creek Field, a field operated by Grand Resources, Inc., just north of Tulsa, west of highway US 75.

- *CONDUCT POWER SOURCE LIFE TEST*

Plans are being finalized to conduct the power source life testing of the field test tool and the rod rotating system at Bird Creek Field (see above paragraph). Discussions have been held with Las Alamos National lab and Lawrence Berkeley National Lab to provide both equipment and personnel to help set and monitor the seismic signal generated during the surface testing.

- *REPORT TO OSAGE TRIBAL REPRESENTATIVES ON PROJECT PROGRESS*

This sub task has not yet been performed.

TASK 5: INSTRUMENT TEST WELLS

- *ENGINEER SEISMIC MEASUREMENT SYSTEM*

Discussions have occurred with Peter Roberts at Los Alamos National Laboratory and Ernie Majors, at Lawrence Berkeley National Laboratory concerning the possibility of utilizing their equipment and services to monitor both surface and downhole geophysical responses to the downhole vibration stimulation. Early communications suggested that the during the source life testing subtask (*Task 4*, above) that activity may be an appropriate time to gather seismic response data as well as during the production stimulation phase (*Task 6*, below).

- *SPECIFY SEISMIC MEASUREMENT SYSTEM*

This sub task will be a combined effort between Peter Roberts at Los Alamos National Laboratory and Ernie Majors, Lawrence Berkeley National Laboratory, Grand Resources and OGCI.

- *INSTALL SEISMIC MEASUREMENT SYSTEM*

The majority of the cost for this phase is in the logistics of re-locating the California based logging truck to the Tulsa area. With the possibility of other testing being conducted in the area by the Berkeley equipment, there is an opportunity to adequately obtain the seismic response data at a nominal expense.

- *REPORT TO OSAGE TRIBAL REPRESENTATIVES ON PROJECT PROGRESS*

This sub task has not yet been performed

Task 6: Conduct Field Vibration Stimulation Tests

Work on this task has not commenced.

Task 7: Report Field Test Results

Work on this task has not commenced.

Task 8: Technology Transfer, Publicize Test Results

- *Write & Submit SPE Paper Abstract*

An abstract for the March 24, 2001 SPE Production Operation Symposium in Oklahoma City was submitted July 17, 2000. The abstract was accepted by the SPE on September 12, 2000 and acknowledge of acceptance was returned to SPE.

Work on the subtasks listed below has not commenced.

- *Author SPE Paper*
- *Prepare Vibration Enhanced Production Workshop*
- *Publicize Vibration Enhanced Production Workshop - PTTC, OIPA, BIA,*
- *Conduct BIA, Tribal Council and Osage County Operators Vibration Enhanced Production Workshop Date TBD*
- *Conduct DOE/IOR/SPE Conference Vibration Enhanced Production Workshop Date TBD*
- *Conduct PTTC OK City Vibration Stimulation Workshop*
- *Conduct PTTC /U of Kansas Vibration Enhanced Production Workshop Date TBD*
- *Author DOE Conference Presentation DATE TBD*
- *Present DOE Conference Paper DATE TBD*
- *Present DOE/BIA Conference Paper DATE TBD*

Task 9: Finish and Close Out Project

Work on this task has not commenced.

Conclusions

Project Management

The DOE Grant Contract DE-FG26-00BC15191 was signed July 13, 2000. The project team is composed of Grand Resources, Inc., Phillips Petroleum Company and Oil & Gas Consultants International and the field test will be conducted on the Osage Reservation.

Technical Issues

The screening criteria for selecting the test well location provided an adequate method for determining where the well should be placed for the vibration test. The three criteria chosen are:

1. Select an area that has good net pay
2. Select and area that has good residual oil saturation
3. Locate the vibration well as close to a producer to maximize the strength of vibration.

The drilling has been delayed due to problems with drilling rig availability.

Phillips has begun testing cores, which were drilled during the 1960s in a field offset to the Blazer Field. No results are yet available.

A prototype for the 7" Downhole Vibration Tool (DHVT) has been built using an improved design. The tests of the prototype have shown an improvement in reliability over earlier designs.

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